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(54) Title: TIME MANAGEMENT USING COMMON CHANNEL SIGNALLING IN A CELLULAR TELECOMMUNICATION NETWORK

(57) Abstract

A time stamp distribution system and corresponding method for a cellular telecommunication network (10), wherein a time distributing master node (20) receives a unique time stamp value from a reliable time source (24), such as a GPS terminal device, and forwards this time stamp value to a plurality of time slave nodes (22a–22c) of the cellular telecommunication system, through the signalling network (14) of the cellular telecommunication network. Upon receipt of the time stamp value, the time slaves nodes can synchronise their own internal clocks (23a–23c), so that time drifts between co-operating cellular nodes are avoided. The time synchronisation sequence can be either manually or automatically initiated from both the master node side and the slave node side.

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TIME MANAGEMENT USING COMMON CHANNEL SIGNALLING IN A CELLULAR TELECOMMUNICATION NETWORK

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to cellular telecommunications, more particularly to the transmission of a time stamp value using the signalling channel for synchronising the nodes of a cellular network.

Description of the Prior Art

A cellular telecommunication network comprises different cellular systems, each one being operated by a cellular operator and comprising different nodes, such as Mobile Switching Centers (MSCs), one or more Home Location Registers (HLRs), a number of Visitor Location Registers (VLRs), and other nodes. Usually, the nodes consist of hardware devices running software programs in order to perform particular functions that allow the cellular system to provide the expected cellular service to subscribers.

In such a cellular telecommunication network, having accurate time value is a critical issue. The time stamp value is used for different essential services provided in the cellular environment, such as for billing, regular maintenance, software updates of the programs running in the nodes, feature activation and deactivation, etc. Furthermore, time synchronisation between nodes in the cellular telecommunication network is crucial as well, in order to insure consistency between databases located at different nodes of the same cellular system. Such databases contain critical information related to billing, significant network-related events such as crush time, etc. For example, often times a call originates in one serving area having a first MSC and ends into another service area having a second MSC. In such cases, which are more and more numerous with the ever-increasing mobility of cellular subscribers, time synchronisation between the two MSCs is critical for producing consistent and

accurate billing records. Other nodes that are not directly supporting cellular calls, such as the Operation Support System (OSS) node, also need accurate time value in order to record the exact time when alarms occur.

Reference is now made to Fig. 1 wherein there is shown a part of a cellular telecommunication network 10 as known in the prior art. More precisely, Fig. 1 may be interpreted as representing either a portion of the cellular telecommunication network 10, as shown, or a portion of a cellular telecommunication system, operated by a unique cellular operator. Both cases are covered by the invention and Fig. 1 shows four cellular nodes 16a to 16d, the nodes communicating with each other through a trunk and signalling network 12. As stated, the prior art description, also illustrated in FIG. 1, applies both to cellular networks and cellular systems, since the time sources are local and individually set-up for each node. According to such a network, the different cellular nodes 16a to 16d individually receive a time stamp value having an independent origin, at regular intervals, from local time sources 18a to 18d that are independent from each other. In such a situation, time drifts between the local time sources 18a to 18d used by each node 16a to 16d are induced in the time value transmitted to the nodes. Consequently, these time drifts, added to the errors coming from the separated clocks of each node, result in considerable time de-synchronisation between the nodes, which may even be of the order of a few minutes. Furthermore, the prior art solution is also costly to implement, since multiple time sources have to be implemented in the telecommunication network, and separate applications have to be set-up and maintained for each node of the network.

This situation is totally inadequate for the cellular telecommunication network 10, even more for the co-operating nodes of a cellular system 11 that require time synchronisation between the nodes being precise to up to one second. The current situation sometimes produces errors of a few minutes in the billing records, in the alarm flag records and other critical time-related applications.

It would be advantageous to have a time source that would send an accurate time stamp value to several nodes in the cellular network, or at least, to all nodes of a cellular system, so that all nodes can regularly synchronise their own clocks 23i in

order to avoid time drifts. It would be even more profitable if such an implementation could be achieved using the existing cellular telecommunication network, so that additional costs related to the implementation of a new transport network is avoided.

Summary of the Invention

It is therefore one broad object of this invention to provide a method for distributing a time stamp value to the nodes of a cellular telecommunication network, or at least to a plurality of nodes of the cellular telecommunication system using an existing signalling network commonly available in the cellular telecommunication network, so that as many nodes as possible can be synchronised in time. According to the invented method, a first node of the cellular network, hereinafter called the either the first node or the time distributing master node, communicates through a signalling network with the other nodes of the network, hereinafter called either the second nodes or the time slave nodes, and receives upon request the accurate time stamp value from a reliable time source, such as for example a Global Positioning System (GPS) terminal device, and then forwards it to the time slave nodes in charge, such as to Mobile Switching Centers, to Home Location Registers, to Visitor Location Registers, etc. According to the preferred embodiment of the invention, the time distributing master node is preferably an Operation Support System (OSS) or a Mobile Switching Center (MSC). However, other cellular nodes as well as a time synchronisation dedicated node of the cellular network can assume that function, too. Upon receipt of the time stamp value, the time slave nodes correct the time drift of their own clocks, i.e. they synchronise their clocks based on the received time stamp value, so that they all become synchronised with each other. The transmission of the time stamp value is done through the signalling network available in the cellular telecommunication system in place, which may be for example a Signalling System 7 (SS7) or a Common Channel Signalling (CCS). Since these two types of signalling networks are the most common in the cellular networks, the Applicant will refer to the CCS/SS7 signalling network throughout the present application. However, it is to be understood that the invention may be applied to other types of signalling networks as well.

The sequence of distributing the time stamp value in order to perform the synchronisation may be initiated either by the time distributing master node or by one of the time slave nodes, upon occurrence of particular events defined by cellular operators. As well, the sequence of distributing the time stamp value, or limited portions of it, may be manually initiated by a network administrator.

For example, according to a preferred embodiment of the invention, the synchronisation sequence may be initiated by one of the slave nodes that detects that a time correction is required, such as after a reboot or a power down period that may have affected the time slave node internal clock. In such a case, the time slave node signals the time distribution master node with a time synchronisation request through the CCS/SS7 signalling channel, the master node requests the accurate time stamp value from the time stamp source and forwards it to the time slave node over the same CCS/SS7 signalling channel.

Accordingly, it is an object of the present invention to provide a method for synchronising the clock of at least one node of a cellular telecommunication network with respect to a time stamp value, the method comprising the steps of:

a) transmitting said time stamp value from a time source to at least one first node, said time source communicating with said at least one first node through a communication link;

b) transmitting said time stamp value from said at least one first node to at least one second node of said cellular telecommunication network through a signalling network of said cellular telecommunication network; and

c) upon receipt of said time stamp value at said at least one second node, synchronising a clock of said second node using said time stamp value.

It is another object of the present invention to provide a cellular telecommunication network comprising:

a time source for generating a time stamp value;

at least one first node receiving said time stamp value through a communication link; and

a signalling network connecting a plurality of second nodes of said cellular

telecommunication network and said first node, at least one of said plurality of second nodes receiving said time stamp value from said first node through said signalling network, said at least one of said plurality of second nodes synchronising its own clock upon receipt of said time stamp value.

Yet another object of the present invention is to provide a cellular telecommunication network, comprising:

a time source for generating a time stamp value;

a plurality of time slave nodes, each of said time slave nodes having an internal time stamp value;

a signalling network connecting a plurality of nodes of said cellular telecommunication network, including said time slave nodes; and

at least one time distributing master node monitoring said internal time stamp value of at least one of said plurality of time slave nodes through said signalling network, said time distributing master node comprising detection means for detecting a time-drift of said internal time stamp value of at least one of said time slave nodes, wherein upon detection of a time-drift in said internal time stamp value of at least one of said second nodes by said detection means of said time distributing master node, the time master node transmits a time stamp value received from said time source to said at least one time slave node through said signalling network, said at least one time slave node using said time stamp value for synchronising its own clock upon receipt of said time stamp value.

Brief Description of the Drawings

For a more detailed understanding of the invention, for further objects and advantages thereof, reference can now be made to the following description, taken in conjunction with the accompanying drawings, in which:

Figure 1 illustrates a prior art method used by cellular nodes for acquiring time stamp value from local independent time sources;

Figure 2 shows a high-level network diagram of the invented system;

Figure 3 is a signalling diagram of a preferred embodiment of the invention, wherein the time synchronisation sequence is initiated by the occurrence of an event at a time distributing master node;

Figure 4 is a signalling diagram of another preferred embodiment of the invention, wherein the time synchronisation sequence is initiated by the occurrence of an event at a time slave node;

Figure 5 is a signalling diagram of another preferred embodiment of the invention, wherein a master node monitors time slave nodes and initiates a time synchronisation sequence upon detection of a time-drift at one particular time slave node; and

Figure 6 is a high-level network diagram of the invented system according to another preferred embodiment of the invention related to the redundant time distributing master node.

Detailed Description of the Preferred Embodiments

Reference is now made to FIG. 2, which illustrates a preferred embodiment of the present invention. According to this embodiment, the nodes of the cellular telecommunication network 10, or at least a plurality of nodes of a cellular telecommunication network 10, represented by numerals 22a to 22c, receive a time stamp value (not shown in Fig. 2) generated by a time source 24 via a time distributing master node 20, through an existing signalling network 14. Preferably, the time source 24 is a unique time source that provides a unique time stamp value to the time distributing master node 20. However, other implementations are possible as well, such as having a pair of time distributing master nodes consisting of a primary master node and a redundant master node, each one being connected to a time source for redundancy purposes.

It is to be noted that the terms "time distributing master node" (abbreviated "master node") and "time slave node" (abbreviated "slave node") are utilised herein for reference to the distribution of the time stamp value only, and not for referencing to the regular operation of the cellular nodes. The relation and inter-operation of the

cellular nodes of a cellular telecommunication network 10 regarding the management and set-up of calls is well known in the art, and it is not the purpose of the present application to discuss this matter.

Furthermore, as also stated beforehand in the present application, even if the invention applies to any kind of signalling network, the Applicant will refer to the signalling network throughout the present application as the CCS/SS7 signalling network as being the communication medium used for performing the time synchronisation sequence. The use of the signalling network of the cellular telecommunication network for the transmission of the time stamp value is one of the key parts of the present invention.

It may be assumed that the present invention would only apply for individual cellular telecommunication systems, since each such system is operated by a particular cellular system operator, i.e. a particular company, that manages and maintains its own system. However, with the ever-increasing mobility of subscribers, interactions between cellular systems become more and more frequent, and roaming from one system to another becomes more and more transparent. Consequently, it would be possible and more and more useful to also apply the present invention to the entire continental or the international cellular telecommunication network 10, so that the clocks of all cellular nodes across the continent or across the world become perfectly synchronised. It is therefore assumed that even if throughout the present application Applicant uses the term cellular telecommunication network, this is not limitative under any circumstances, and the invention may be applied as well to a portion of the network only, such as to an individual cellular telecommunication system, or a portion of it.

In the preferred embodiment of the invention, the master node 20 may preferably be an Operation Support System (OSS) node whose primary function is to monitor and manage the functioning of the other nodes of the cellular telecommunication network 10. Although this is the preferred implementation for Ericsson TDMA cellular systems, the master node 20 may be as well an MSC or any other node that is part of and connected to the cellular telecommunication network 10

through a CCS/SS7 signalling network 14 of the telecommunication network 10.

According to this preferred embodiment of the invention, each one of the slave nodes 22a to 22c is connected to the CCS/SS7 signalling network 14 through corresponding signalling links 28a to 28d. The signalling network 14 is preferably a CCS/SS7 signalling network that is mainly utilised for setting up and for surveillance of calls. The centralised time source 24 is preferably a unique time source, such as GPS terminal device, that provides a very accurate time stamp value. The master node 20 receives this time stamp value through a communication link 27 and immediately forwards it to the slave nodes 22a to 22c through the CCS/SS7 signalling network 14. Upon receipt of the time stamp value, each one of the slave nodes 22a to 22c synchronises its own clock 23a to 23c using the time stamp value. As a result of this operation, the internal clocks 23a to 23c of the slave nodes 22a to 23c are now perfectly synchronised. Thus, slave nodes time drifts are eliminated and all operations performed at each one of the slave nodes are now recorded using accurate and consistent time stamp values. In the present application, the term "perfectly synchronise" means that the clocks of the master node 20 and of the slave nodes 22i are synchronised within an acceptable error range with respect to each other, which in the existing cellular telecommunication networks may be of the order of half a second to one second. Since one of the main purposes of the time synchronisation is to allow both sufficiently consistent and sufficiently accurate records regarding the billing and the alarm flags, and since usually these records contain a time stamp precise to one second, a time synchronisation having the same precision, i.e. up to the order of one second is believed to be sufficient.

In this preferred embodiment of the invention, it is the master node 20 that initiates the time synchronisation sequence, as illustrated in FIG. 3. A time synchronisation-initiating event may be previously programmed by a network operator in order to initiate that sequence. Such an event may be the expiration of a pre-defined time period, so that the time synchronisation is performed at pre-defined time intervals, the detection of a network or slave-node-related error that may have induced a time-drift at one or more slave nodes, or any other event that may affect or require

the time synchronisation. In order to perform these tasks, the master node 20 may further comprise detection means 21 as better shown in Fig. 2, in dotted line, since the detection means 21 are optinal and specific to this preferred embodiment of the invention. The detection means 21 may be for example, program modules being set up in order to monitor and detect the presence of the described time synchronisation-initiating event. Alternatively, the detection means may be hardware modules which function is to detect the master node time synchronisation event 30, or any other means judged suitable for performing this detection function in the cellular telecommunication network. This event may also be the down status of the CCS/SS7 signalling network. This will start the time synchronisation sequence after a crush period of the network on the assumption that the crush could have induced a time drift in the node clocks.

After the detection of the event, action 30, by the detectection means 21, the master node 20 immediately requests the time stamp value from the time source 24 through a TIME REQUEST signal 32. Upon receipt of the signal 32, the time source 24 responds with the time stamp value through a Time Request response signal 34. The master node 20 then forwards the time stamp value through a TIME FORWARD message 36 to a first slave node 22a, which upon receipt of the time stamp value uses that value in order to synchronise its own internal clock 23a, through action 38. Preferably, when the slave node time synchronisation 38 is completed, the slave node 22a may respond back to the master node 20 with a Time Forward Acknowledgement 40 in order to inform the master node that the operation was successful. In the opposite case, the master node 20 is informed through the same message 40 of the failure of the operation, and the time stamp value is then read again form the time source 24 and re-transmitted to the slave node 22a. However, in order to facilitate the comprehension of FIG. 3, this re-transmission is not illustrated. Given the fact that the information forwarded to the slave nodes is the time stamp value, the delay for forwarding is critical. If the availability of the communication links between the master node 20 and the slave nodes 22a to 22c induces non-negligible delays, each time the synchronisation involves a new slave node, the time stamp value may be read again

by the master node 20 from the time source 24. However, it is assumed that this worst case only seldom happens, so that reading only once the time stamp value from the time source 24, as illustrated in FIG. 3, is sufficient for providing the synchronisation accuracy needed in a common cellular system 10. Furthermore, in practice, it is assumed that the delay for performing the totality of the synchronisation sequence described beforehand is less than the maximum tolerable error induced in the time synchronisation, provided that a reasonable number of slave nodes 22i are synchronised.

A similar sequence is performed for all subsequent slave nodes from the cellular telecommunication network 10 that are set-up for receiving the time stamp value from the same master node 20.

It is to be understood that only the preferred implementation of the invention has been disclosed. However, it is also possible that the same invention be implemented in different variants without departing from its spirit. For example, it is also possible for the preferred embodiment of the invention presented in FIG. 3, that the TIME FORWARD messages towards the slave nodes 22i be simultaneously or consecutively transmitted in order to avoid delays and perform even more accurate time synchronisations between cellular nodes when a great number of slave nodes are to be synchronised by the same master node 20. Since the Time Forward Acknowledgement messages are not time critical (like the TIME FORWARD messages are), the master node 20 may then wait for receiving these Acknowledgement messages independently and in a succeeding manner.

Reference is now made to the FIG. 4 of the Drawings, wherein a second preferred embodiment of the invention is disclosed. According to this second preferred embodiment, it is the slave nodes 22i that initiate their individual time synchronisation, upon detection of a slave node time synchronisation-initiating event, action 50, at the slave node 22i. As illustrated, such a situation involves one slave node only, designated 22a in FIG. 4. The slave node time synchronisation initiating-event may be the detection of a significant time-drift in the internal clock 23a of the slave node 22a, the occurrence of a power-down period followed by a

system recovery, that may have induced a time-drift, the presumption that a time-drift may exist between the internal clock 22a and other node's clock, such as for example 23b, or any other automatically or manually-performed event defined by a network operator or administrator. As also stated for the master node, the slave node too may monitor the status of the CCS/SS7 signalling network, and then initiate the synchronisation sequence after a crush period that could have induced a time drift in its clock. Of course, for action 50 to happen, the slave node 22a comprises detection means 25a, better seen on Fig. 2, in dotted lines, since the detection means 25i are optional and specific to this preferred embodiment of the invention. The detection means 25i may be, for example, software modules previously set up by a network administrator in order to monitor and detect the slave node time synchronisation initiating event 50. For example, an application program may be programmed in order to regularly monitor for occurrence, or for a previously determined probability of occurrence, of these events and for triggering the time synchronisation. Alternatively, as for the master node detection means 21, slave node detection means 25i may be hardware modules set up to perform the required tasks, or any other suitable means. In a variant of this preferred embodiment, the action 50 may be a manually-activated event, such as the manual activation of the time synchronisation sequence by a network administrator. However, it is believed that the most frequent time synchronisation initiating event that can occur in practice is the recovery of a system after a crush period.

When the slave node time synchronisation initiating event is detected by the slave node, action 50, a TIME SYSNCHRONISATION REQUEST message 52 is sent by the slave node 22a to the master node 20. Upon receipt of the message 52, the master node 20, requests the time stamp value from the time source 24 through a TIME REQUEST message 32, and obtains the value through a Time Request response message 34. The master node 20 immediately forwards the time stamp value to the slave node 22a through a Time Synchronisation request response message 54. Upon receipt of the time stamp value, the slave node 22a immediately synchronises its own internal clock 23a using value, and upon success of the

operation 38, returns back a TIME SYNCHRONISATION REQUEST ACKNOWLEDGEMENT 58 to the master node 20, in order to inform the master node 20 of the success/failure of the operation. In case of failure, the time synchronisation sequence may be entirely repeated. However, it is considered that this worst case only seldom happens, so it was not illustrated in FIG. 4.

According to the third preferred embodiment of the invention, there is provided a method wherein the master node 20 regularly monitors the time value of the internal clocks 23i of each slave node 22i, and upon detection of a significant time-drift by the detection means 21 of the master node 20, better seen on Fig. 2, that may be, for example, greater than a pre-defined threshold value, performs a time synchronisation for this particular slave node. As illustrated in FIG. 5 of the Drawings, the described synchronisation sequence relating to this preferred embodiment starts with the detection of a master node time synchronisation event, action 60, such as the expiration of a pre-defined time period, or any other event previously set-up by a network operator or administrator in the detection means 21 of the master node 20. Such an event may be as well the manual activation of the sequence.

Upon occurrence of the master node time synchronisation event, action 60, the master node 20 starts monitoring the slave nodes 22i. FIG. 5 only shows 2 different slave nodes 22a and 22b, but it is to be understood that a larger number of slave nodes 22i may be monitored by a master node 20 during the same synchronisation sequence. According to this third preferred embodiment of the invention, the master node 20 transmits a TIME MONITOR message 62 to the slave node 22a in order to read the time value 63 of the slave node 22a. This time value 63 is returned back to the master node 20 through the Time Monitor response message 64. Upon receipt of the slave node time value 63, the master node requests the time stamp value from the time source 24, and obtains it through the Time Request Response message 34, as previously described in the present application. Having both the time stamp value obtained from the time source 24 and the slave node time value 63, the master node 20 may compare them, through action 66. In

the present situation it is assumed that the time stamp value and the slave node time stamp value 63 differ by more than a threshold value previously defined. In such a case, the master node transmits the time stamp value to the slave node 22a through the TIME FORWARD message 36 and, upon receipt of the time stamp value, the slave node 22a immediately synchronises its internal clock 23a, action 38, thus eliminating the time-drift that caused the time synchronisation sequence to be initiated. As previously described, once the clock synchronisation operation is terminated, the slave node 22a responds back with a Time Forward Acknowledgement message 40 in order to inform the master node 20 of the success/failure of the operation 38. In case of failure, the portion of the synchronisation sequence concerning that particular node 22a may be entirely repeated.

After a successful time synchronisation of the slave node 22a, the synchronisation of the remaining slave nodes whose time values depend of the same master node 20 continues. The same procedure is applied to all remaining slave nodes, one node at a time. The remaining part of FIG. 5, shows the case wherein the difference between the time value 63 of the slave node 22b and the time stamp value provided by the time source 24 is less than the pre-defined threshold value. In such a case, after having performed the evaluation 66a, the master node 20 terminates the synchronisation for that particular node, since there is no need for sending the time stamp to the slave node 22b.

It is to be noted that it may be preferable that each time the master node 20 performs the portion of the synchronisation sequence for one particular slave node, the time stamp value is read again from the time source 24. This may minimise delays that could generate errors in the time stamp value, between the moment of reading the time stamp value to the moment of the evaluation 66.

However, in a variant of the present embodiment, if these delays are considered to be minimal and if they do not affect the desired accuracy of the time synchronisation, it may be advantageous to only read once the time stamp value from the time source 24, and then monitor the local time value 63i of all slave

nodes 22i concerned, and perform the time synchronisation when required, for particular slave nodes.

Although the previous description of the preferred embodiments focussed on the time synchronisation of the slave nodes 22i, it is to be understood that the synchronisation sequences described in FIG. 3 and 4, respectively corresponding to the first and second preferred embodiments of the invention as described beforehand in the present application, may be adapted in order to include the synchronisation of the master node 20, each time the time value is read from the time source 24. Indeed, the master node 20 may be set-up in such a manner that each time it reads the time stamp value from the time source 24 it also synchronises it own internal clock 23 through action 37, similar to the one performed by each slave node 22i, as shown in FIG. 3 and 4. As for the slave nodes, various implementations of the invention may be applied for the synchronisation of the master node 20, which has a direct connection to the time source 24. This may take the form of a regularly performed independent synchronisation that only involves the master node 20 and the time source 24 (this variant is not shown), or may be part of a global synchronisation sequence during which the master node 20 may synchronise its own clock 23 as well, when performing synchronisation of other clocks 23i of the slave nodes 22i, as shown in FIG. 3 and 4. The result of such a synchronisation sequence is that a plurality of nodes of the cellular telecommunication network 10 have internal clocks that are synchronised using the same time stamp value, so that time drifts between co-operating nodes are eliminated.

According to another preferred embodiment of the invention shown in FIG. 6, in order to insure maximum reliability for the time synchronisation process, the master node 20 may be a primary master node 20a and may be redundant, i.e. another node, called the redundant master node 20b may be set-up in the cellular telecommunication network for performing the time synchronisation functions when the primary master node is not available, such as when a crash of the primary master node occurs, or when the network portion joining the primary master node

to the rest of the cellular nodes has crushed. Just as the master node 20 that was previously described in the present application, the redundant master node 20b may be preferably an OSS node, or any other node of the cellular telecommunication system, such as an MSC. According to this preferred embodiment of the invention, the functioning of the primary master node 20a may be regularly monitored by the redundant master node 20b, preferably through the same CCS/SS7 signalling network 14, and when a malfunction related to the incapacity of the primary master node 20a to perform time synchronisation for the slave nodes is detected, the redundant master node 20b may immediately replace the primary master node and perform these tasks. The redundant master node 20b may receive the time stamp value from the same time source 24 through a communication link 27, as shown in FIG. 6, or from any other time source connected to the redundant master node 20b.

In another preferred embodiment of the invention, there is provided a converting function for converting the time stamp value received by each one of the slave nodes 22i according to the local time zone of each slave node. The converting function may take in consideration the time zone of the time source 24 and/or of the master node 20, and the time difference between the time zone of the time source and/or the master node, and the slave node receiving the time stamp value.

One of the numerous advantages of the present invention is that it provides an economic and easy-to-implement method for completely eliminating time drifts in a cellular telecommunication system. Having a central time stamp value being distributed to a plurality of nodes using the existing CCS/SS7 signalling network is a tremendous improvement over the existing systems that have separate time sources for each node.

Although several preferred embodiments of the method and system of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

What is claimed:

1. A method for synchronising the clock of at least one node of a cellular telecommunication network with respect to a time stamp value, the method comprising the steps of:

a) transmitting said time stamp value from a time source to at least one first node, said time source communicating with said at least one first node through a communication link;

b) transmitting said time stamp value from said at least one first node to at least one second node of said cellular telecommunication network through a signalling network of said cellular telecommunication network; and

c) upon receipt of said time stamp value at said at least one second node, synchronising a clock of said second node using said time stamp value.

2. The method claimed in claim 1, wherein said signalling network is a CCS/SS7 signalling network of said cellular telecommunication network, said CCS/SS7 signalling network connecting said at least one first node with said at least one second node.

3. The method claimed in claim 2, further comprising prior to step b) a step of synchronising a clock of said at least one first node using said time stamp value.

4. The method claimed in claim 2, wherein said at least one first node is a time distributing master node, said at least one second node is a plurality of time slave nodes, said master node distributing said time stamp value to said plurality of time slave nodes, each one of said time slave nodes synchronising their own clock upon receipt of said time stamp value from said master node.

5. The method claimed in claim 2, wherein said at least one first node comprises two time distributing master nodes, a first one of said master nodes being a primary master node and a second one of said master nodes being a redundant master node, said redundant master node performing time synchronisation related functions of said primary master node when said primary master node is not available.

6. The method claimed in claim 4, wherein the step a) is initiated upon detection of a synchronisation initiating event by said time distributing master node, said synchronisation initiating event being previously manually defined by a network administrator.

7. The method claimed in claim 4, further comprising:

prior to step a), a step of monitoring an internal time stamp value of said plurality of time slave nodes from said cellular telecommunication system; and

prior to step b), a step of evaluating for accuracy said internal time stamp value of said plurality of time slave nodes from said cellular telecommunication system and upon detection of a drift of said internal time stamp value for one of said plurality of time slave nodes with respect to said time stamp value received from said time source, proceeding with step c).

8. The method claimed in claim 4, wherein the step a) is initiated upon detection of a time synchronisation initiating event by one of said plurality of time slave nodes, said event being previously manually defined by a network administrator.

9. The method claimed in claim 8, wherein upon detection of said time synchronisation initiating event by one of said plurality of time slave nodes, when said signalling network is not accessible for said one of said plurality of time slave nodes, said one time slave node of said plurality of time slave nodes sets a time-drift alarm,

regularly monitors the status of said signalling network and upon detection of an idle state of said signalling network, initiates step a).

10. The method claimed in claim 4, wherein said time distributing master node is an Operation Support System (OSS) node and said time source is a Global Positioning System (GPS) terminal device, said GPS terminal device communicating with said time distributing master node through the communication link and providing said time stamp value to said time distributing master node.

11. The method claimed in claim 4, wherein step a) is manually initiated by a network administrator.

12. A cellular telecommunication network comprising:

a time source for generating a time stamp value;

at least one first node receiving said time stamp value through a communication link; and

a signalling network connecting a plurality of second nodes of said cellular telecommunication network and said first node, at least one of said plurality of second nodes receiving said time stamp value from said first node through said signalling network, said at least one of said plurality of second nodes synchronising its own clock upon receipt of said time stamp value.

13. The cellular telecommunication network as claimed in claim 12, wherein said first node is a time distributing master node, said plurality of second nodes is a plurality of time slave nodes, said master node distributing said time stamp value to said plurality of slave nodes.

14. The cellular telecommunications network as claimed in claim 13, wherein said signalling network is a CCS/SS7 signalling network

15. The cellular telecommunications network as claimed in claim 13, wherein said time distributing master node comprises a primary master node and a redundant master node, said redundant master node performing time synchronisation related functions of said primary master node when said primary master node is not available.

16. The cellular telecommunications network as claimed in claim 14, wherein said time distributing master node further comprises detection means for detecting of a time synchronisation initiating event, wherein upon detection of said time synchronisation initiating event by said detection means, said time distributing master nodes reads the time stamp value from said time source and sends said time stamp value to at least one of said plurality of time slave nodes of said cellular telecommunication network through said CCS/SS7 signalling network of said cellular telecommunication network, wherein upon receipt of said time stamp value, said at least one of said plurality of time slave nodes synchronises its own clock using said time stamp value.

17. The cellular telecommunications network as claimed in claim 14, wherein at least one time slave node of said plurality of time slave nodes further comprises detection means for detecting a time synchronisation event, wherein upon detection of said time synchronisation event by said detection means, said at least one time slave node of said plurality of time slave nodes requests said time stamp value to be transmitted by said master node, and synchronises its own clock upon receipt of said time stamp value from said time distributing master node.

18. A cellular telecommunication network, comprising:

a time source for generating a time stamp value;

a plurality of time slave nodes, each of said time slave nodes having an internal time stamp value;

a signalling network connecting a plurality of nodes of said cellular telecommunication network, including said time slave nodes; and

at least one time distributing master node monitoring said internal time stamp value of at least one of said plurality of time slave nodes through said signalling network, said time distributing master node comprising detection means for detecting a time-drift of said internal time stamp value of at least one of said time slave nodes, wherein upon detection of a time-drift in said internal time stamp value of at least one of said second nodes by said detection means of said time distributing master node, the time master node transmits a time stamp value received from said time source to said at least one time slave node through said signalling network, said at least one time slave node using said time stamp value for synchronising its own clock upon receipt of said time stamp value.

19. The cellular telecommunication network claimed in claim 18, wherein said signalling network is the CCS/SS7 signalling network.

20. The cellular telecommunication network claimed in claim 18, wherein the monitoring performed by said master node is manually initiated by a network administrator.

21. The cellular telecommunication network claimed in claim 18, wherein the monitoring performed by said time distributing master node is automatically initiated by a time synchronisation initiating event detected by said detection means of said time distributing master node, said initiating event being previously defined by a network administrator.

22. The cellular telecommunication network claimed in claim 18, wherein said time distributing master node synchronises its own clock upon receipt of said time stamp value form said time source.

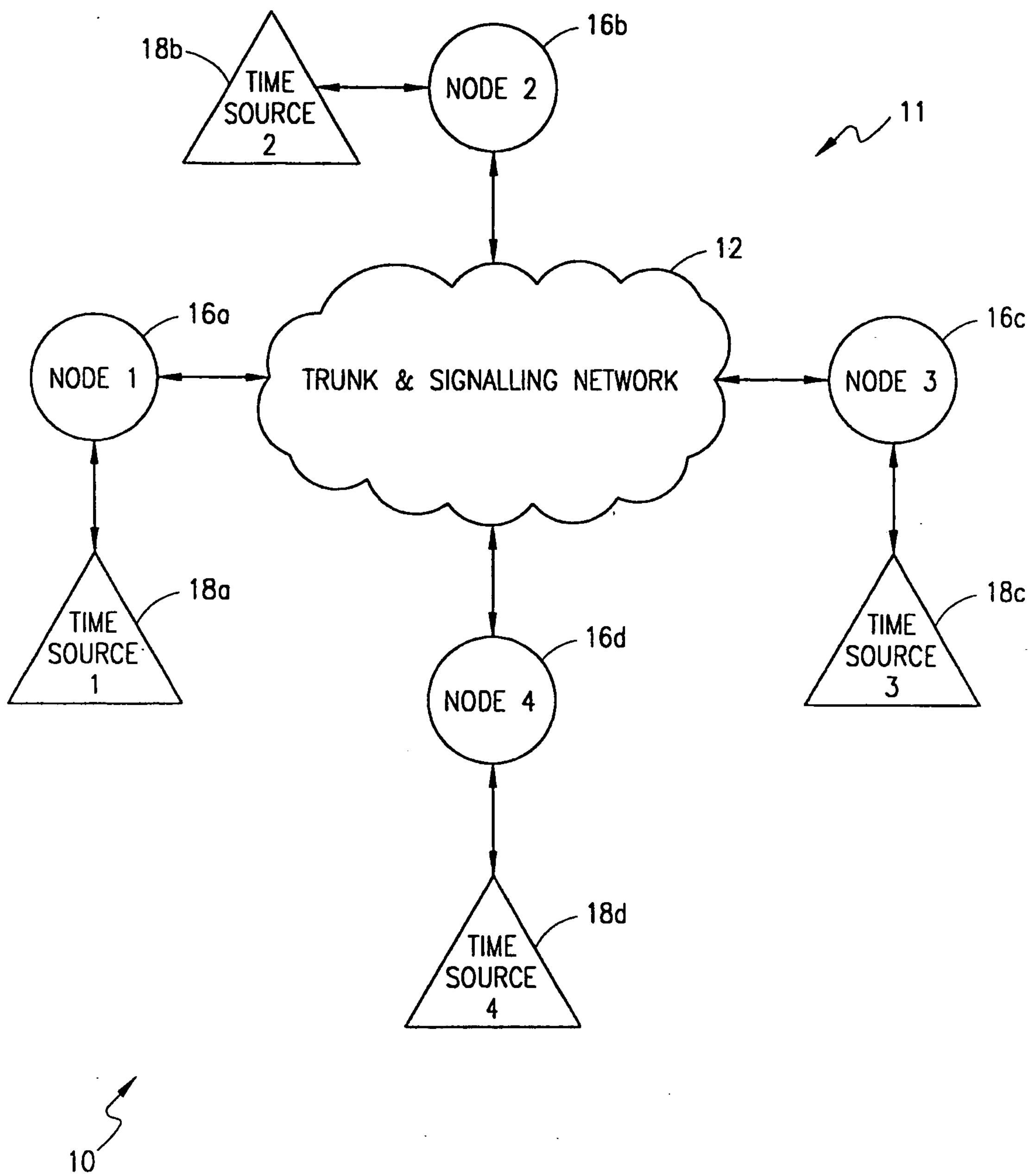


FIG. 1
(PRIOR ART)

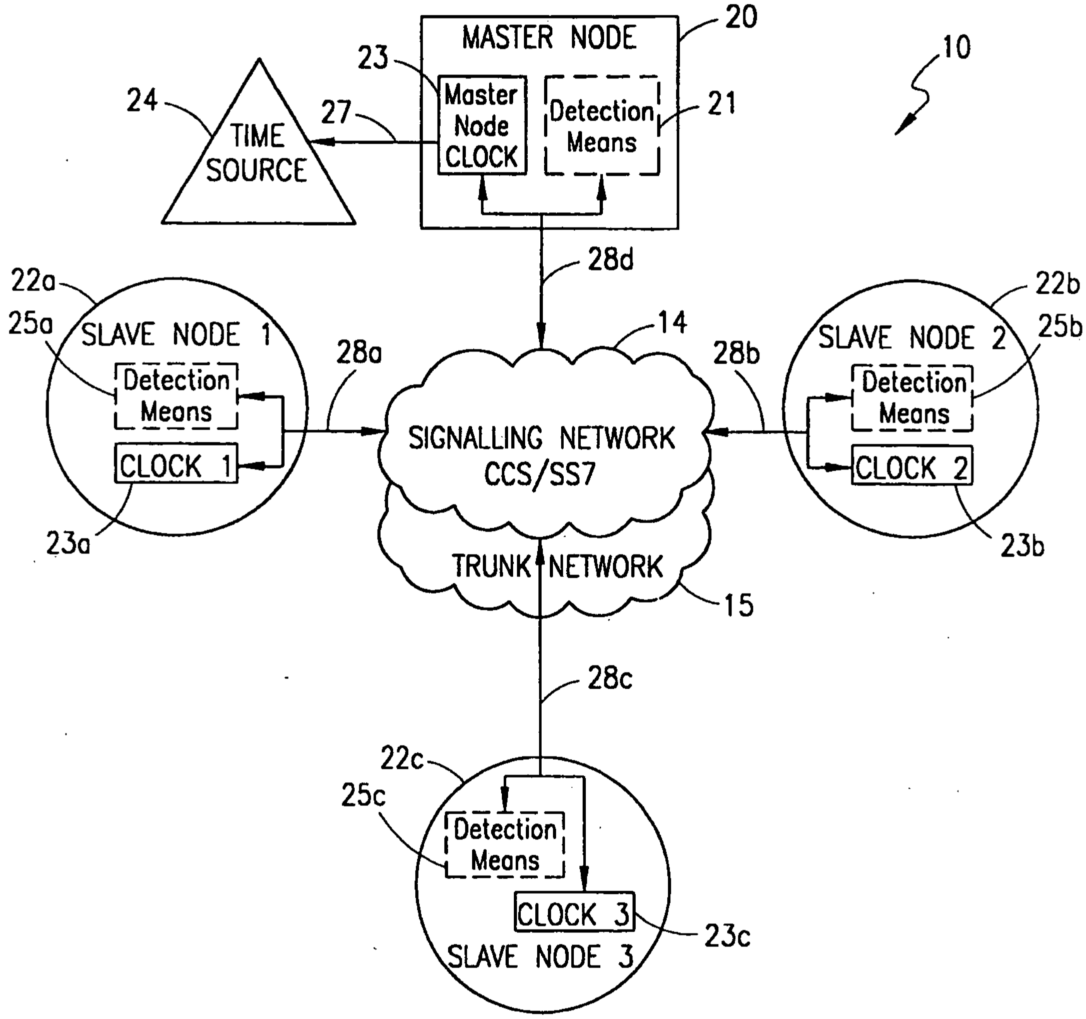
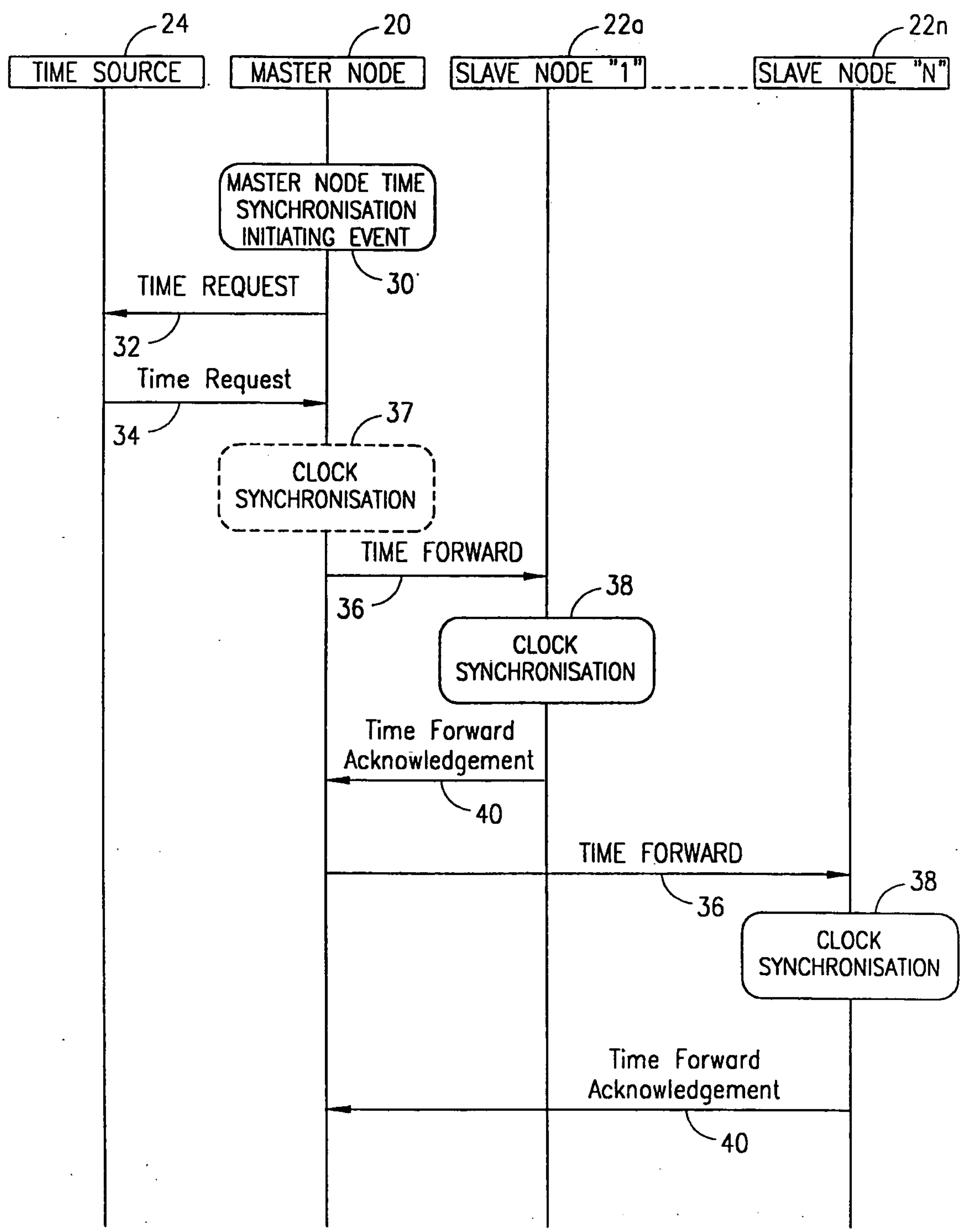

MASTER NODE
20
10
23
Master Node CLOCK
Detection Means
21
24
TIME SOURCE
27
28d
22a
SLAVE NODE 1
25a
Detection Means
CLOCK 1
23a
28a
14
SIGNALLING NETWORK CCS/SS7
TRUNK NETWORK
15
28b
22b
SLAVE NODE 2
25b
Detection Means
CLOCK 2
23b
28c
22c
25c
Detection Means
CLOCK 3
23c
SLAVE NODE 3

FIG. 2



24
20
22a
22n
TIME SOURCE
MASTER NODE
SLAVE NODE "1"
SLAVE NODE "N"
MASTER NODE TIME SYNCHRONISATION INITIATING EVENT
30
TIME REQUEST
32
Time Request
34
37
CLOCK SYNCHRONISATION
TIME FORWARD
36
38
CLOCK SYNCHRONISATION
Time Forward Acknowledgement
40
TIME FORWARD
36
38
CLOCK SYNCHRONISATION
Time Forward Acknowledgement
40

FIG. 3

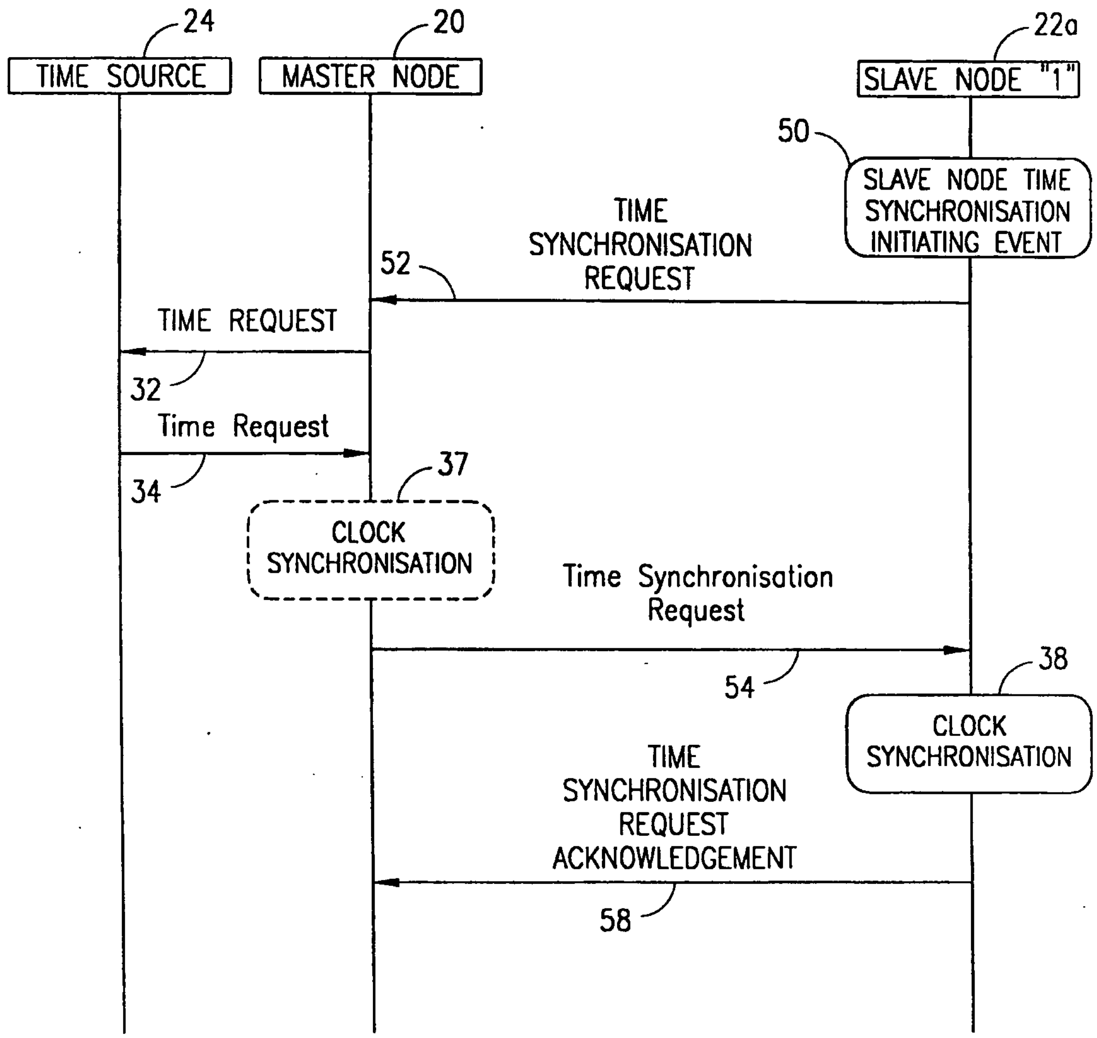

24
20
22a
TIME SOURCE
MASTER NODE
SLAVE NODE "1"
50
SLAVE NODE TIME SYNCHRONISATION INITIATING EVENT
TIME SYNCHRONISATION REQUEST
52
TIME REQUEST
32
Time Request
34
37
CLOCK SYNCHRONISATION
Time Synchronisation Request
54
38
CLOCK SYNCHRONISATION
TIME SYNCHRONISATION REQUEST ACKNOWLEDGEMENT
58

FIG. 4

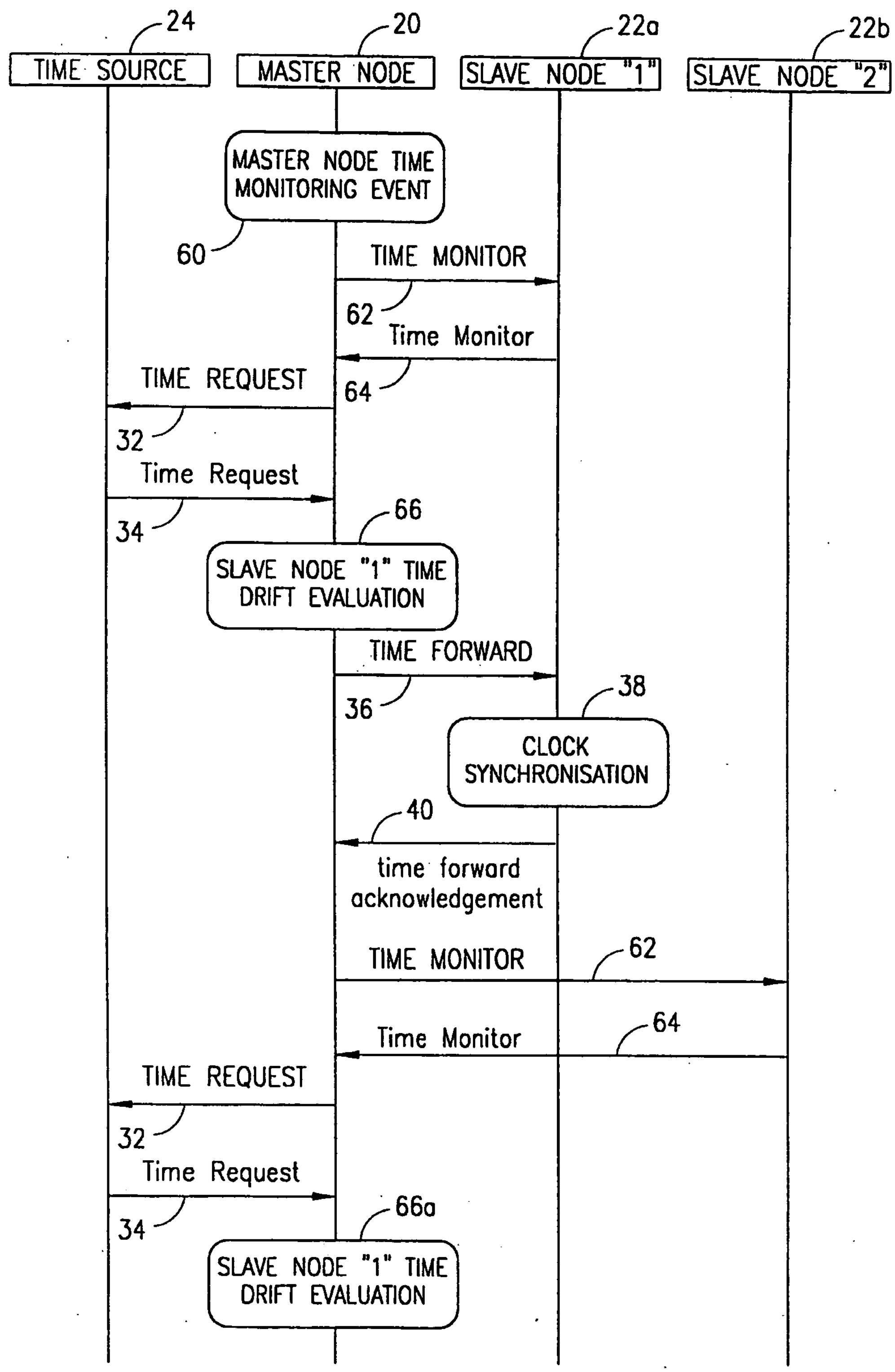

24
TIME SOURCE
20
MASTER NODE
22a
SLAVE NODE "1"
22b
SLAVE NODE "2"
MASTER NODE TIME MONITORING EVENT
60
TIME MONITOR
62
Time Monitor
64
TIME REQUEST
32
Time Request
34
66
SLAVE NODE "1" TIME DRIFT EVALUATION
TIME FORWARD
36
38
CLOCK SYNCHRONISATION
40
time forward acknowledgement
TIME MONITOR
62
Time Monitor
64
TIME REQUEST
32
Time Request
34
66a
SLAVE NODE "1" TIME DRIFT EVALUATION

FIG. 5

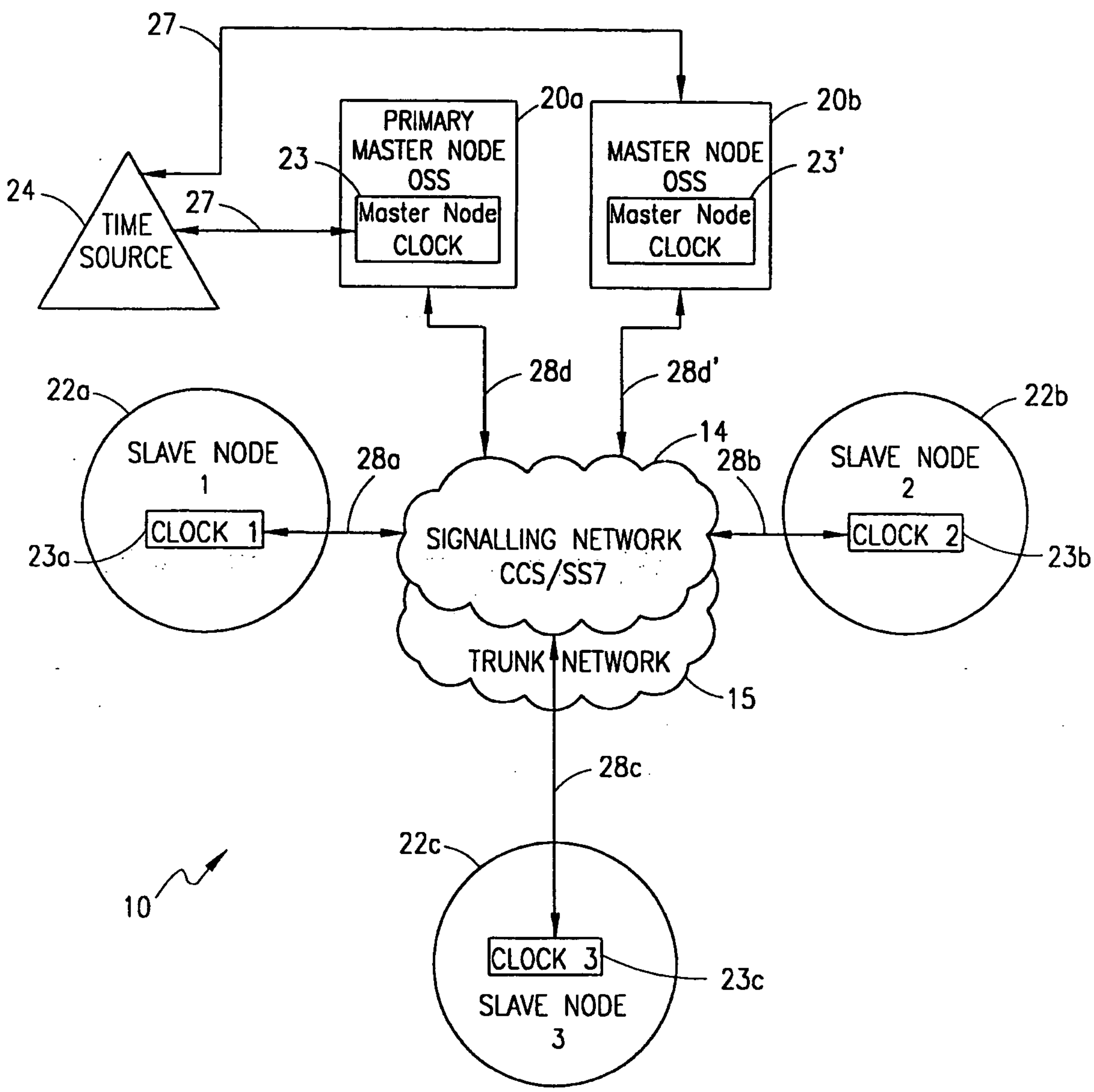

27
PRIMARY
MASTER NODE
OSS
20a
MASTER NODE
OSS
20b
23
23'
24
TIME
SOURCE
27
Master Node
CLOCK
Master Node
CLOCK
28d
28d'
22a
SLAVE NODE
1
CLOCK 1
23a
28a
14
28b
22b
SLAVE NODE
2
CLOCK 2
23b
SIGNALLING NETWORK
CCS/SS7
TRUNK NETWORK
15
28c
22c
10
CLOCK 3
23c
SLAVE NODE
3

FIG. 6